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IN THE UNITED STATES PATENT & TRADEMARK OFFICE

IN RE APPLICATION OF

HIROAKI TANIUCHI, ET AL.

: EXAMINER: M. MIGGINS

SERIAL NO: 10/621,652

FILED: JULY 18, 2003

: GROUP ART UNIT: 1772

FOR: CEMENT COMPOSITE, CONCRETE, CONCRETE CASK AND METHOD OF  
MANUFACTURING CONCRETE

SUPPLEMENTAL APPEAL BRIEF

COMMISSIONER FOR PATENTS  
ALEXANDRIA, VIRGINIA 22313

SIR:

This is an appeal from the Final Rejection of the claims dated January 3, 2006.

I. REAL PARTY IN INTEREST

The real parties in interest are Kabushiki Kaisha Kobe Seiko Sho of Hyogo, Japan and Taisei Corporation of Tokyo, Japan, by the assignment recorded on August 25, 2003 at Reel/Frame 014424/0516.

II. RELATED APPEALS AND INTERFERENCES

Appellants, Appellants' legal representative and their assignee are not aware of any appeals or interferences which will directly affect or be directly affected by or having a bearing on the Board's decision in this appeal.

### III. STATUS OF THE CLAIMS

The appealed claims are Claims 1-7, 15 and 16.

Claims 8-14 and 17-25 are also pending, but are withdrawn from consideration.

### IV. STATUS OF AMENDMENTS

No amendments to the claims have been submitted subsequent to the mailing of the Final Rejection dated January 3, 2006.

### V. SUMMARY OF THE CLAIMED SUBJECT MATTER

In one embodiment, recited in Claim 1 and described in the specification at page 4, lines 7-15, the present invention relates to a radiation shielding material comprising:

Portland cement [page 4, lines 8-9]; and

at least one metallic material selected from the group consisting of iron, carbon steel and stainless steel in any of particulate, powder and fiber forms [page 4, lines 9-11]; and  
wherein

the radiation shielding material has a content of calcium hydroxide in a range of 15% to 60% by mass after hardening through hydration reaction, and the content of the at least one metallic material is in a range of 10% to 70% by mass after hardening through hydration reaction [page 4, lines 11-15].

In another embodiment, recited in Claim 2, the content of calcium hydroxide is in a range of 20% to 50% by mass after hardening through hydration reaction. See the specification at page 6, lines 15-16.

In another embodiment, recited in Claim 3, the content of the metallic material is in a range of 30% to 70% by mass after hardening through hydration reaction. See the specification at page 39, lines 18-24.

In another embodiment, recited in Claim 4, the Portland cement is included in blended cement which is prepared by mixing at least one material selected from the group consisting of blast-furnace slag, water-granulated blast-furnace slag, air-cooled blast-furnace slag, air-cooled slag, converter slag, copper slag, ferronickel slag, silica fume, fly ash, coal ash, clay, shirasu, diatomaceous earth and grain ash with Portland cement. See the specification at page 39, lines 25 to page 40, line 8.

In another embodiment, recited in Claim 5, the radiation shielding material further comprises a neutron-absorbing material which is mixed in such a manner that the content of the neutron-absorbing material is in a range of 0.025% to 10% by mass after hardening through hydration reaction. See the specification at page 40, lines 9-14.

In another embodiment, recited in Claim 6, the neutron-absorbing material includes at least one substance selected from the group consisting of boron carbide, boric acid, boron oxide, ferroboron and borated stainless steel. See the specification at page 40, lines 15-18.

As recited in Claim 7, and described in the specification at page 4, lines 7-15 and page 40, lines 19-22, the present invention also relates to a concrete radiation shielding material comprising Portland cement [page 4, lines 9-11], and at least one metallic material selected from the group consisting of iron, carbon steel and stainless steel in any of particulate, powder and fiber forms [page 4, lines 9-11], and wherein the concrete radiation shielding material has a content of calcium hydroxide in a range of 15% to 60% by mass after hardening through hydration reaction, and the content of the at least one metallic material is in a range of 10% to 70% by mass after hardening through hydration reaction [page 4, lines 11-15].

In another embodiment, recited in Claim 15, the radiation shielding material further comprises at least one metallic material selected from the group consisting of iron, copper, tungsten, iron alloy, copper alloy, tungsten alloy, iron compound, copper compound and tungsten compound in any of particulate, powder and fiber forms. See the specification at page 42, lines 10-15.

In another embodiment, recited in Claim 16, at least one metallic material selected from the group consisting of iron, iron alloy, copper and copper alloy is mixed in said composite in such a manner that the content of the at least one metallic material falls in a range of 10% to 70% by mass after hardening through hydration reaction. See the specification at page 42, lines 16-21.

#### VI. GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

1. The rejection of Claims 1-3, 5-7 and 15-16 under 35 U.S.C. 103(a) over Borst (U.S. patent No. 2,726,339) in view of Kanjiro et al. (JP 06-294897).
2. The rejection of Claim 4 under 35 U.S.C. 103(a) over Borst in view of Kanjiro et al. and further in view of Stocker et al. (U.S. 3,002,843).

#### VII. ARGUMENT

1. Claims 1-3, 5-7 and 15-16 are Not Unpatentable Under 35 U.S.C. 103(a) Over Borst in View of Kanjiro et al.

##### Claims 1 and 7

Borst describes a concrete radiation shielding medium for providing protection from radioactive substances. The concrete may contain various levels of metallic materials

including iron. However, as the Examiner notes on page 3 of the Office Action dated January 3, 2006, Borst does not teach or suggest calcium hydroxide in a range of 15 to 60% by mass after hardening through hydration reaction.

Kanjiro et al. describes an aggregate for use in producing a cement structure for radioactive waste.<sup>1</sup> Kanjiro et al. describe the need for the cement to have a high pH to minimize corrosion of metal in the radioactive waste structure. The pH is an important factor for securing long term safety of storing radioactive waste disposal objects, because at a high pH (e.g. pH  $\geq$  10, preferably pH  $\geq$  12) corrosion of metal components is inhibited, solubility of the radionucleotides is low, and microorganism activity is inhibited. See paragraph [0008] of Kanjiro et al.

Kanjiro et al. recognize that cement (concrete) structures made of conventional cements have a high pH, because conventional cements react with water to form Ca(OH)<sub>2</sub> [paragraph 0009]. However, Kanjiro et al. find Ca(OH)<sub>2</sub> in cement paste disappears relatively fast, so that the cement (concrete) structures seems to be impossible to maintain at a high-pH [paragraph 0011] as shown by the soxhlet extraction test, a description of which is submitted herewith [paragraph 0010].

For that reason, Kanjiro et al. use cement clinker in a specified size as aggregate, and find the that percentage of Ca(OH)<sub>2</sub> in the specimen increases from 0 to about 2% in about 215 hours by the soxhlet extraction test [paragraph 0011, FIG. 1].

Thus, Kanjiro et al. do not add Ca(OH)<sub>2</sub> in the aggregate or the cement. Ca(OH)<sub>2</sub> is believed to be formed by the reaction with water locatede on the surface of the cement clinker [paragraph 0013]. The existence of Ca(OH)<sub>2</sub> affects the pH of the cement [paragraph 0010], but does not cause to hardening of the concrete. Therefore, the content of Ca(OH)<sub>2</sub> increases

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<sup>1</sup> A machine translation of Kanjiro et al. was submitted on March 14, 2006.

from 0 to about 2% in about 215 hours by the reaction described above, but that increase does not contribute to the hardness of the concrete.

Besides, the increase of  $\text{Ca}(\text{OH})_2$  described by Kanjiro et al. occurs in a period of less than 9 days, and only shows up to 2% [FIG. 1]. From this view point 2% of  $\text{Ca}(\text{OH})_2$  is enough to keep the cement (concrete) structures at a high pH.

In the Advisory Action dated April 17, 2006, the Examiner stated with respect to Kanjiro et al. that:

...the calcium hydroxide is added to hardened concrete to control the pH and the calcium hydroxide remains in the concrete mixture for hundreds of hours long after the hardening...

However, there is no description of adding calcium hydroxide to the hardened concrete in Kanjiro et al.! The Office is respectfully requested to cite the portion of Kanjiro et al. relied on to support the statement above.

Regarding Figure 1 of Kanjiro et al., the important three terms are defined as follows:

“cement particle” is a grain made by pulverizing cement clinker or conventional cement, and has a grain size of  $30\mu\text{m}$  or less in diameter, and is used for cement;

“cement clinker aggregate” is a grain made by pulverizing the material in accordance with the preparation specified by Kanjiro et al., and has a grain size of 5mm or less in diameter, and is used for aggregate [see paragraph 0015, 0018]; and

“hardened cement paste” is a concrete consisting of “cement particles” and water, and has been hardened by hydration of the “cement particles”.

The Examiner has presumed that “concrete using low-heat type cement clinker in a specified size as aggregate” contains about 2% of  $\text{Ca}(\text{OH})_2$  in about 215 hours. This presumption is based on the graph in Fig. 1 in Kanjiro et al.

However, it is illogical to presume from his graph that concrete using low-heat type cement clinker contains about 2% of  $\text{Ca}(\text{OH})_2$  for the following reasons.

According to the recitation in [paragraph 0010] of Kanjiro et al., the amount of  $\text{Ca}(\text{OH})_2$  on the vertical axis of the graph shown in Fig. 1 is the residual amount in the specimen, and is calculated by the following formula:

$$\begin{aligned} & \text{the (residual) amount of } \text{Ca}(\text{OH})_2 \\ &= \text{initial amount } \text{Ca}(\text{OH})_2 \text{ in the specimen of the soxhlet extraction test} \\ & - \text{extract amount } \text{Ca}(\text{OH})_2 \text{ in the exudates.} \end{aligned}$$

On the contrary, according to the graph, the amount of  $\text{Ca}(\text{OH})_2$  in "cement clinker aggregate" is zero at the initial time, and that the amount is increased to about 2% at 215 hours elapsed.

Thus, this increase does not make sense, because the extract amount in the exudates at 215 hours has to be a negative value of 2%.

Further, even if the increase should make sense, Kanjiro et al. has the following inconsistency.

The graph which represents the result of the soxhlet extraction test in Kanjiro et al. only shows that  $\text{Ca}(\text{OH})_2$  in "hardened cement paste" solves in water faster than  $\text{Ca}(\text{OH})_2$  in "cement clinker aggregate". Kanjiro et al. do not conduct any actual aging tests of a structural object. Kanjiro et al. measured the amount of  $\text{Ca}(\text{OH})_2$  in the exudates by soxhlet extraction apparatus which used water as solvent [see paragraph 0010].

It is known that hydration inward "cement particles" in cement concrete reacts very slow. It is also known that "cement particles" sampled from cement concrete of an actual structural object that had been hydrated for one hundred or more years were microscopically observed and showed the cement particle had unreacted internal part.

In a "cement clinker aggregate", hydration in the surface layer (several micrometers) of the  $30\mu\text{m}$  sized clinker reacts relatively fast to form  $\text{Ca}(\text{OH})_2$  during the first approximately ten days, however, after that, hydration in the internal part of the cement

clinker aggregate reacts extremely slow, so that the formation of  $\text{Ca}(\text{OH})_2$  seems to be stopped.

In other words, cement clinker aggregate in the concrete undergoes very slow hydration comparing with the soxhlet extraction test of Kanjiro et al. where cement clinker aggregates were directly exposed to pure distilled water. The Examiner fails to distinguish the present invention from Kanjiro et al. Namely, hydration in the soxhlet extraction test is quite different from hydration in an actual structural object. Therefore, the graph of Fig. 1 in Kanjiro et al. does not teach cement clinker aggregate totally contains 2% of  $\text{Ca}(\text{OH})_2$  after 215 hours from hardening.

Therefore, the value approximately 18.6% which is the amount of  $\text{Ca}(\text{OH})_2$  in hardened cement paste consisting of cement particles and water at the initial time in Kanjiro et al. only indicate the amount of  $\text{Ca}(\text{OH})_2$  in the exudates through hydration reaction measured by the soxhlet extraction test. This value does not indicate the actual content in the hardened cement paste, while the amount of  $\text{Ca}(\text{OH})_2$  in the radiation shielding material of the present invention including the metallic material indicates that actual content of  $\text{Ca}(\text{OH})_2$  after hardening through hydration reaction (see page 3, lines 5-7 from the bottom in the Final Office Action dated January 3, 2006).

In view of the foregoing, the cement formulation described in Kanjiro et al. does not contain calcium hydroxide in a range of 15 to 60% by mass after hardening through hydration reaction, as explicitly specified in independent Claims 1 and 7. Because the combination of Borst and Kanjiro et al. fails to suggest a radiation shielding material with a content of calcium hydroxide in a range of 15% to 60% by mass after hardening through hydration reaction, the claimed material would not have been obvious over those references. Therefore, the Examiner has failed to establish a *prima facie* case of obviousness.

As noted above, the goal in Kanjiro et al. was to maintain a high pH in the cured cement over a long period of time to minimize corrosion of metal in the cement structure. The goal was achieved by utilizing aggregates in the cement formulation which allowed for a residual calcium hydroxide concentration of at most 2% in the cement structure only based on the results of the soxhlet extraction test.

In contrast, one of the goals of the claimed invention is to improve the radiation shielding ability of the radiation shielding material. This improvement leads to a reduction in the thickness of the shielding structure which in turn leads to smaller and lighter structures (see page 12 of the specification).

Applicants have found that the claimed radiation shielding material gives superior properties in regard to radiation shielding particularly with regard to neutron-shielding performance by retaining water in the form of a crystalline structure of which melting temperature and decomposition temperature exceed 100°C (see page 6, lines 21-24 of the specification). These results are illustrated in Fig. 1 of the present application which plots the relative dose rate as a function of the content of calcium hydroxide in the finished structure (lower dose rates mean better shielding). Fig. 1 illustrates the drastic decrease in relative dose rate (increase in radiation shielding) when the radiation shield material contains 15% by mass or higher of calcium hydroxide. Namely, the relative dose rate with respect to neutrons becomes smaller than 1 when the calcium hydroxide content is 15% or higher. On the other hand, the relative dose rate with respect to neutrons is about 2.3 when the calcium hydroxide content is 10% (see page 10, line 15 to page 11, line 1). This means the concrete containing 10%  $\text{Ca(OH)}_2$  is not useful as a radiation shielding material. The concrete containing 2%  $\text{Ca(OH)}_2$  which is disclosed in Kanjiro et al. is not useful for a radiation shielding material, either. Applicants note that neither cited reference teaches or suggests the role of calcium hydroxide in radiation shielding. Accordingly, the claimed radiation shielding material

would not have been obvious over the combination of Borst and Kanjiro et al., and therefore, the rejection should be withdrawn.

Claim 2

Claim 2 depends from Claim 1, and further specifies that the content of calcium hydroxide is in a range of 20% to 50% by mass after hardening through hydration reaction. The combination of Borst and Kanjiro et al. fails to suggest the radiation shielding material specified in Claim 1 as discussed above. Those references certainly fail to suggest such a material in which the content of calcium hydroxide is in a range of 20% to 50% by mass after hardening through hydration reaction.

Claim 3

Claim 3 depends from Claim 1, and further specifies that the content of the metallic material is in a range of 30% to 70% by mass after hardening through hydration reaction. The combination of Borst and Kanjiro et al. fails to suggest the radiation shielding material specified in Claim 1 as discussed above. Those references certainly fail to suggest such a material in which the content of the metallic material is in a range of 30% to 70% by mass after hardening through hydration reaction.

Claim 5

Claim 5 depends from Claim 1, and further specifies a neutron-absorbing material which is mixed in such a manner that the content of the neutron-absorbing material is in a range of 0.025% to 10% by mass after hardening through hydration reaction. The combination of Borst and Kanjiro et al. fails to suggest the radiation shielding material specified in Claim 1 as discussed above. Those references certainly fail to suggest such a

material in which further comprises a neutron-absorbing material which is mixed in such a manner that the content of the neutron-absorbing material is in a range of 0.025% to 10% by mass after hardening through hydration reaction.

Claim 6

Claim 6 depends from Claim 5, and further specifies that the neutron-absorbing material includes at least one substance selected from the group consisting of boron carbide, boric acid, boron oxide, ferroboron and borated stainless steel. The combination of Borst and Kanjiro et al. fails to suggest the radiation shielding material specified in Claim 5 as discussed above. Those references certainly fail to suggest such a material in which the neutron-absorbing material includes at least one substance selected from the group consisting of boron carbide, boric acid, boron oxide, ferroboron and borated stainless steel.

Claim 15

Claim 15 depends from Claim 1, and further specifies at least one metallic material selected from the group consisting of iron, copper, tungsten, iron alloy, copper alloy, tungsten alloy, iron compound, copper compound and tungsten compound in any of particulate, powder and fiber forms. The combination of Borst and Kanjiro et al. fails to suggest the radiation shielding material specified in Claim 1 as discussed above. Those references certainly fail to suggest such a material in which further comprises at least one metallic material selected from the group consisting of iron, copper, tungsten, iron alloy, copper alloy, tungsten alloy, iron compound, copper compound and tungsten compound in any of particulate, powder and fiber forms.

### Claim 16

Claim 16 depends from Claim 15, and further specifies that at least one metallic material selected from the group consisting of iron, iron alloy, copper and copper alloy is mixed in said composite in such a manner that the content of the at least one metallic material falls in a range of 10% to 70% by mass after hardening through hydration reaction. The combination of Borst and Kanjiro et al. fails to suggest the radiation shielding material specified in Claim 15 as discussed above. Those references certainly fail to suggest such a material in which at least one metallic material selected from the group consisting of iron, iron alloy, copper and copper alloy is mixed in said composite in such a manner that the content of the at least one metallic material falls in a range of 10% to 70% by mass after hardening through hydration reaction.

2. Claim 4 is Not Unpatentable Under 35 U.S.C. 103(a) over Borst in view of Kanjiro et al. and Further in View of Stocker et al.

Claim 4 depends from Claim 1, and further specifies that the Portland cement is included in blended cement which is prepared by mixing at least one material selected from the group consisting of blast-furnace slag, water-granulated blast-furnace slag, air-cooled blast-furnace slag, air-cooled slag, converter slag, copper slag, ferronickel slag, silica fume, fly ash, coal ash, clay, shirasu, diatomaceous earth and grain ash with Portland cement.

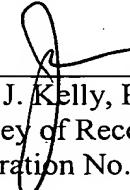
As discussed above, Claim 1 is not obvious over Borst in view of Kanjiro et al.

Stocker et al. disclose concrete structures having high resistance to fire and radiation. See column 2, lines 27-33 and Examples I-V. Stocker et al. fails to disclose or suggest a radiation shielding material has a content of calcium hydroxide in a range of 15% to 60% by mass after hardening through hydration reaction, as specified in Claim 1. Accordingly, the combination of Borst, Kanjiro et al. and Stocker et al. fail to suggest the claimed material.

In view of the foregoing, the rejections of the appealed claims under 35 U.S.C. §103(a) should be reversed.

Respectfully Submitted,

OBLON, SPIVAK, McCLELLAND,  
MAIER, & NEUSTADT, P.C.  
Norman F. Oblon

  
James J. Kelly, Ph.D.  
Attorney of Record  
Registration No.: 41,504

Customer Number  
22850

Tel.: (703) 413-3000  
Fax: (703) 413-2220

## CLAIMS APPENDIX

The appealed claims, i.e., Claims 1-7, 15 and 16, read as follows:

Claim 1. A radiation shielding material comprising:

Portland cement; and

at least one metallic material selected from the group consisting of iron, carbon steel and stainless steel in any of particulate, powder and fiber forms; and wherein

the radiation shielding material has a content of calcium hydroxide in a range of 15% to 60% by mass after hardening through hydration reaction, and the content of the at least one metallic material is in a range of 10% to 70% by mass after hardening through hydration reaction.

Claim 2. The radiation shielding material according to claim 1, wherein the content of calcium hydroxide is in a range of 20% to 50% by mass after hardening through hydration reaction.

Claim 3. The radiation shielding material according to claim 1, wherein the content of the metallic material is in a range of 30% to 70% by mass after hardening through hydration reaction.

Claim 4. The radiation shielding material according to claim 1, wherein said Portland cement is included in blended cement which is prepared by mixing at least one material selected from the group consisting of blast-furnace slag, water-granulated blast-furnace slag, air-cooled blast-furnace slag, air-cooled slag, converter slag, copper slag, ferronickel slag, silica fume, fly ash, coal ash, clay, shirasu, diatomaceous earth and grain ash with Portland cement.

Claim 5. The radiation shielding material according to claim 1, further comprising a neutron-absorbing material which is mixed in such a manner that the content of the neutron-absorbing material is in a range of 0.025% to 10% by mass after hardening through hydration reaction.

Claim 6. The radiation shielding material according to claim 5, wherein the neutron-absorbing material includes at least one substance selected from the group consisting of boron carbide, boric acid, boron oxide, ferroboron and borated stainless steel.

Claim 7. A concrete radiation shielding material comprising Portland cement, and at least one metallic material selected from the group consisting of iron, carbon steel and stainless steel in any of particulate, powder and fiber forms, and wherein the concrete radiation shielding material has a content of calcium hydroxide in a range of 15% to 60% by mass after hardening through hydration reaction, and the content of the at least one metallic material is in a range of 10% to 70% by mass after hardening through hydration reaction.

Claim 15. The radiation shielding material according to claim 1 further comprising at least one metallic material selected from the group consisting of iron, copper, tungsten, iron alloy, copper alloy, tungsten alloy, iron compound, copper compound and tungsten compound in any of particulate, powder and fiber forms.

Claim 16. The radiation shielding material according to claim 15, wherein at least one metallic material selected from the group consisting of iron, iron alloy, copper and copper alloy is mixed in said composite in such a manner that the content of the at least one metallic

material falls in a range of 10% to 70% by mass after hardening through hydration reaction.

## EVIDENCE APPENDIX

A copy of "Soxhlet Extraction Apparatus" discussed herein. This document has not been previously entered into the record by the Examiner. It is submitted herewith to address the arguments presented by the Examiner in the Advisory Action dated April 17, 2006.

RELATED PROCEEDINGS APPENDIX

None.